DISTRIBUTION OF A SYSTEMIC INSECTICIDE IN COTTON PLANTS AFTER STEM TREATMENTS

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DISTRIBUTION OF A SYSTEMIC INSECTICIDE IN COTTON PLANTS AFTER STEM TREATMENTS

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ABSTRACT

A systemic insecticide, American Cyanamid CL–47031, cyclic ethylene (diethoxyphosphinyl) dithioimidocarbonate, was applied to the stems of young cotton plants in a lanolin paste. Its subsequent distribution in the foliage was estimated by bioassay with cotton aphids, *Aphis gossypii* Glover, and adult boll weevils, *Anthonomus grandis* Boheman. The distribution of the toxicant in the upper three leaves and terminal was adequate to produce high mortalities of test insects after treatment of only one-third of the circumference of the stem. With the same treatment, however, uneven and variable distribution occurred in the lower three leaves and resulted in variable insect control.

INTRODUCTION

Lindquist et al. (*7*)[3] first suggested the possible economic use of the stem treatment method of applying systemic insecticides to cotton plants. They found the method much more efficient in getting dicrotophos into a cotton plant than soil treatment, seed treatment, or foliar spray. Tests in the greenhouse and in field cages have shown that the stem treatment method is promising for the control of the carmine spider mite, *Tetranychus telarius* (L.), and the cotton aphid, *Aphis gossypii* Glover (*11*); the cotton fleahopper, *Psallus seriatus* (Reuter) (*14*); lygus bugs, *Lygus* spp. (*1, 8, 12*); the cotton bollworm, *Heliothis zea* (Boddie), and the tobacco budworm, *H. virescens* (F.) (*10*); and boll weevils, *Anthonomus grandis* Boheman (*13*).

Presently, preliminary greenhouse and field studies with the stem treatment method of applying systemic insecticides are conducted by applying the toxicant in a 1- to 3-inch band around the

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[3] Italic numbers in parentheses refer to items in "Literature Cited" at the end of this publication.

stem, and a rotary brush applicator has been developed for field use (*9*). Hacskaylo and Hoverson (*3*), using ^{32}P-labeled monocrotopho, applied insecticide to only one side of the lower stem of young cotton plants, but reported that when insecticide was applied in that way accumulation was greater in the leaves on the treated side than on the side opposite the treatment site. Subsequent studies have shown that the pattern of accumulation of certain solutes in cotton following stem applications and petiole infusion could be correlated with xylem arrangement, transpiration, and site of application of the solute (*5, 6*). If, however, despite irregular accumulation, treating only a portion of the stem results in distribution of the toxicant in the plant adequate for insect control, the design of stem treatment machines for field use can probably be simplified.

The experiments reported herein were designed to determine, by bioassay, whether the distribution of American Cyanamid CL–47031, cyclic ethylene(diethoxyphosphinyl)dithioimidocarbonate, in the cotton plant following stem applications would be similar to that reported for monocrotophos utilizing radiometric techniques (*3*).

MATERIALS AND METHODS

Cotton plants of the 'Deltapine–15' variety were grown singly in 1-gallon containers filled with soil. Special consideration was given to the possible role of the morphology of the cotton plant in determining the relative pattern of translocation. Leaves are attached to the main stem of cotton plants in a spiral pattern to the right or left, each petiole being about three-eighths of a turn (135°) around the stem in a horizontal plane from the petiole beneath it (*2*). All plants had six true main-stem leaves, and only those with a counterclockwise phyllotaxy were used. The cotyledons were detached from the petioles 1 week prior to treatment, and the petioles were allowed to abscise.

Three milligrams of American Cyanamid CL–47031 in 50 milligrams of lanolin was applied to the stem of each plant. A 1-inch vertical band of formulation was always applied 1 to 1½ inches below the level of the lowest true leaf, but directly beneath leaf 1, 2, or 3, or in a complete band around the stem. When only a portion of the stem was treated, one-third of the circumference of the stem was covered with a lanolin and insecticide formulation. Treatment locations in relation to leaf positions are illustrated in figure 1. Leaves were numbered consecutively beginning at the bottom of the plant, and each treatment was replicated three to six times.

Either the lower 3 leaves or all 6 leaves plus the terminal were infested with 25 to 50 cotton aphids per leaf 24 or 48 hours prior to treatment. A record of the numbers of aphids on each leaf was made immediately before treatment and at regular intervals thereafter. After 7 days either the bottom three leaves or all six leaves

plus the terminal were detached from the plant at the petiole/leaf-blade junction and fed individually to 5- to 7-day-old adult boll weevils in ½-pint glass containers. Counts of live and dead boll weevils were made 3 days later.

RESULTS AND DISCUSSION

Different levels of reduction in aphid populations on the various leaves (table 1) were evident 24 hours after treatment, but the differences were more pronounced 48 hours after treatment. In all cases, the aphid populations on the lower three leaves were reduced by the largest amount on the leaf directly above the treated area and by the smallest amount on the leaf at the greatest distance around the stem from the treated area. Leaves 1 and 3 were approximately equal in distance around the stem from leaf 2, but in opposite directions. When the toxicant was applied in the area beneath leaf 2, aphid population reduction was higher on leaf 3 than on leaf 1, which indicated that the vascular system at the site of application was more directly connected to leaf 3 than to leaf 1. The

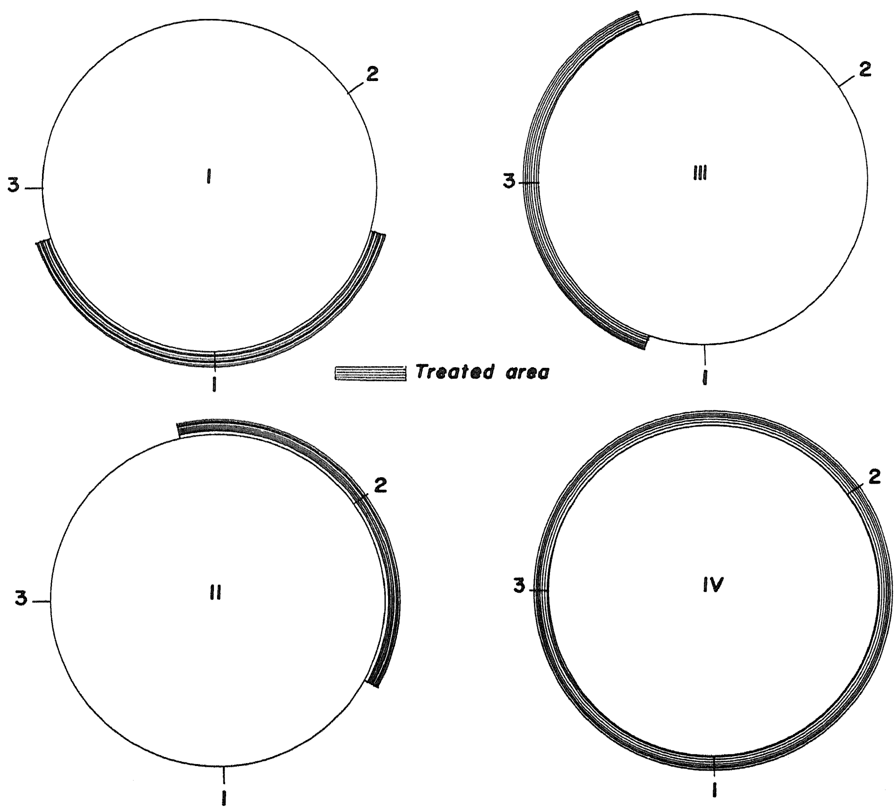

FIGURE 1.—Diagrammatic presentation of areas of stems treated. I, Treated under leaf 1. II, Treated under leaf 2. III, Treated under leaf 3. IV, Treated in a complete band around the stem.

application of the toxicant in a complete band around the stem resulted in nearly equal aphid reduction on all leaves, but in no case was there a 100-percent reduction in aphids in the lower three leaves when the toxicant was applied to a portion of the stem. The results suggest that the distribution of the toxicant was much more variable in the lower three leaves than the upper leaves, but that the leaf directly above the treatment area received more toxicant than either of the other two lower leaves. Further, the toxicant apparently was distributed in a higher concentration in the upper leaves and terminal than in the lower leaves, which was probably a result of the higher transpiration rate of the younger upper leaves (*3, 4, 6*). That there was a higher percentage reduction in aphid population

TABLE 1.—*Percent reduction in aphids after application of 3 milligrams CL–47031 to cotton stems at selected locations*

Treatment[1]	Leaf[2]	Hours after treatment: 24	36	48
I	1	20 (0–25)	88 (70–94)	88 (62–100)
	2	30 (0–50)	69 (59–87)	42
	3	34 (0–58)	74 (42–100)	76 (30–100)
	4	86 (80–98)	92 (82–100)	100
	5	76 (50–92)	82 (58–100)	100
	6	86 (80–92)	94 (91–100)	100
	T	66 (50–86)	88 (72–100)	100
II	1	0 (0–16)	32 (25–50)	28 (34–99)
	2	24 (10–58)	89 (88–94)	93 (75–100)
	3	35 (0–50)	72 (68–75)	62 (40–76)
	4	80 (60–98)	82 (80–96)	100
	5	86 (74–100)	90 (78–100)	100
	6	78 (66–90)	86 (76–95)	100
	T	84 (80–100)	90 (82–100)	100
III	1	0 (0–16)	26 (11–30)	76 (48–98)
	2	0 (0–27)	51 (38–69)	73 (47–88)
	3	42 (26–53)	94 (91–100)	94
	4	79 (64–80)	92 (76–95)	100
	5	83 (77–92)	92 (82–98)	100
	6	92 (77–100)	96 (83–100)	100
	T	56 (32–80)	27 (11–44)	100
IV	1	70 (68–81)	99 (96–100)	100
	2	48 (25–68)	86 (68–96)	98 (96–100)
	3	71 (49–100)	80 (52–94)	100
	4	88 (78–98)	96	98 (96–100)
	5	94 (82–98)	93 (82–99)	100
	6	80 (64–94)	92 (81–100)	100
	T	87 (83–92)	100	100

[1] See fig. 1 for a diagrammatic representation of area of stem treated. Each figure is an average of 4–8 replicates. Insecticide was applied in a lanolin paste.

[2] Leaves were numbered from the bottom of the plant. T=terminal.

in 48 hours when the toxicant was applied in a complete band around the stem can probably be attributed to the fact that a greater surface area of the stem was covered by the formulation, which caused more of the toxicant to penetrate the stem.

In the first of two series of experiments utilizing the boll weevil bioassay procedure and only the lower three leaves, the observed mortality among boll weevils (table 2) indicated the same general pattern of toxicant distribution as the aphid data. When the stems were treated under leaf 1, leaves 2 and 3 received less of the toxicant; treatments under leaf 2 resulted in less of the toxicant being translocated to leaves 1 and 3 than to leaf 2. When treatment was under leaf 3, however, leaf 1 received much more of the toxicant than leaf 2.

In a second series of experiments, utilizing the boll weevil bioassay and all six leaves plus the terminal, the results were variable (table 3), but there still appeared to be relatively uniform distribution of the toxicant in the upper leaves, while the lower leaves still showed evidence of the pattern of unequal and variable distribution of toxicant.

TABLE 2.—*Percent mortality (72-hour) of adult boll weevils fed leaves removed from plants 7 days after stem treatment with 3 milligrams CL–47031*

Leaf No.	Treatment location[1]		
	I	II	III
1	60 (60–60)	28 (22–33)	47 (30–50)
2	33 (28–38)	62 (60–66)	22 (12–30)
3	30 (25–40)	38 (20–40)	46 (33–60)

[1] 3 replicates of 10 weevils each. See fig. 1 for explanation of treatment location.

TABLE 3.—*Mortality (72-hour) of adult boll weevils fed leaves removed from plants 7 days after stem treatment with 3 milligrams CL–47031*

Leaf No.	Percent mortality with treatment[1]				Check (actual mortality)
	I	II	III	IV	
1	53 (50–50)	33 (32–35)	29 (22–38)	30 (30–30)	10
2	24 (20–28)	70 (43–90)	22 (12–30)	40 (40–40)	0
3	50 (11–80)	19 (10–30)	59 (34–90)	70 (70–70)	0
4	86 (80–90)	86 (70–100)	36 (20–60)	86 (80–90)	0
5	83 (80–90)	90 (70–100)	90 (80–100)	90 (90–90)	0
6	83 (80–90)	93 (90–100)	80 (70–90)	83 (80–99)	10
T	56 (30–80)	76 (70–90)	30 (10–50)	73 (50–100)	0

[1] Each figure is an average of 2–3 replicates of 10 weevils each. See fig. 1 for explanation of treatment location.

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